Amendment to the Claims

In the Claims:

Please amend Claim 13 as follows:

1. (Previously Presented) A method for estimating a thickness of a wall of a lumen from an image of the lumen, comprising the steps of:

(a) in an image of the lumen, identifying an inner contour and an outer contour;

(b) performing a low resolution triangulation function to define triangles between the inner contour and the outer contour;

(c) adding additional triangles between the inner contour and the outer contour;

(d) analyzing edges of the triangles that were defined and added using a minimal energy function to identify triangle edges that correspond to a width between the inner contour and the outer contour;

(e) comparing triangle edges identified as corresponding to a width between the inner contour and the outer contour to identify a minimum width and a maximum width corresponding respectively to a minimum wall thickness and a maximum wall thickness of the lumen; and

(f) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

2. (Original) The method of Claim 1, further comprising the steps of repeating steps (c) and (d) until a desired resolution is achieved, such that additional triangle edges identified as corresponding to a width between the inner contour and the outer contour are compared to identify the minimum and the maximum width.

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3. (Original) The method of Claim 1, wherein the step of performing the low resolution triangulation function comprises the steps of:

(a) decomposing the inner contour into a low resolution inner contour set using wavelet analysis;

(b) decomposing the outer contour into a low resolution outer contour set using wavelet analysis; and

(c) computing tiling for the low resolution inner contour set and the low resolution outer contour set using greedy triangulation.

4. (Original) The method of Claim 1, wherein the step of analyzing the edges of the triangles using the minimal energy function comprises the step of using a Delaunay triangulation MaxMin angle property to determine the minimal energy function.

5. (Original) The method of Claim 4, wherein the step of analyzing edges of the triangles using the minimal energy function further comprises the step of performing an edge flipping operation on the edges of the triangles.

6. (Original) The method of Claim 1, wherein the step of adding additional triangles between the inner contour and the outer contour comprises the steps of:

(a) inserting additional vertices onto each of the inner contour and the outer contour, such that triangles defined between the inner contour and the outer contour are converted to quadrilaterals; and

(b) constructing an edge from each inserted vertex on one of the inner contour and the outer contour to a corresponding quadrilateral vertex on the other of the inner contour and the outer contour, thereby converting each quadrilateral into a pair of triangles.

7. (Original) The method of Claim 1, wherein steps (a)-(e) are at least partially executed automatically by a computing device.

8. (Previously Presented) The method of Claim 1, further comprising the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors for the lumen.

9. (Previously Presented) The method of Claim 8, wherein the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors comprises the step of calculating a plurality of area descriptors.

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10. (Original) The method of Claim 9, wherein the step of calculating a plurality of area descriptors comprises the steps of calculating at least two of the following:

(a) an area of the lumen;

(b) an outer wall boundary area of the lumen;

(c) a wall area of the lumen; and

(d) a ratio of the area of the lumen to the outer wall boundary area.

11. (Previously Presented) The method of Claim 8, wherein the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors comprises the step of calculating a plurality of simple descriptors, each simple descriptor being based on a one dimensional distance determined for the lumen.

12. (Original) The method of Claim 11, wherein the step of calculating a plurality of simple descriptors comprises the steps of calculating at least two of the following:

(a) a mean of lumen boundary radii;

(b) a minimum of the lumen boundary radii;

(c) a maximum of the lumen boundary radii;

(d) a ratio of the minimum of the lumen boundary radii to the maximum of the lumen boundary radii;

(e) a ratio of the minimum of the lumen boundary radii to the mean of the lumen boundary radii;

(f) a ratio of the mean of the lumen boundary radii to the maximum of the lumen boundary radii; and

(g) a ratio of a standard deviation of the lumen boundary radii to the mean of the lumen boundary radii.

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13. (Currently Amended) The method of Claim 11, wherein the step of calculating a plurality of simple descriptors comprises the steps of calculating at least two of the following:

(a) a mean of outer wall boundary radii;

(b) a minimum of the outer wall boundary radii;

(c) a maximum of the outer wall boundary radii;

(d) a ratio of the minimum of the outer wall boundary radii to the maximum of the outer wall boundary radii;

(e) a ratio of the minimum of the outer wall boundary radii to the mean ~~of outer~~ of the outer wall boundary radii;

(f) a ratio of the mean of the outer wall boundary radii to the maximum of the outer wall boundary radii; and

(g) a ratio of a standard deviation of the outer wall boundary radii to the mean of the outer wall boundary radii.

14. (Original) The method of Claim 11, wherein the step of calculating a plurality of simple descriptors comprises the steps of calculating at least two of the following:

(a) a mean of all wall thicknesses of the lumen that were determined;

(b) a ratio of the minimum wall thickness to the maximum wall thickness;

(c) a ratio of the minimum wall thickness to the mean of all wall thicknesses;

(d) a ratio of the mean of all wall thicknesses to the maximum wall thickness; and

(e) a ratio of a standard deviation of all wall thicknesses to the mean of all wall thicknesses.

15. (Previously Presented) The method of Claim 8, wherein the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate the plurality of morphological descriptors comprises the step of calculating a plurality of complexity descriptors, each complexity descriptor being based on two different dimensional distances determined for the lumen.

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16. (Original) The method of Claim 15, wherein the step of calculating a plurality of complexity descriptors comprises the steps of calculating at least two of the following:

(a) a ratio of a minimum of lumen radii to a mean of wall radii for the lumen;

(b) a ratio of a maximum of lumen radii to the mean of the wall radii;

(c) a ratio of a mean of the lumen radii to the mean of the wall radii; and

(d) a ratio of a distance between a centroid of the lumen and a centroid of the outer wall boundary to the mean of the wall radii.

17. (Original) The method of Claim 15, wherein the step of calculating a plurality of complexity descriptors comprises the steps of calculating at least two of the following:

(a) a ratio of the minimum wall thickness to a mean of wall radii;

(b) a ratio of the maximum wall thickness to the mean of the wall radii; and

(c) a ratio of the mean of all wall thicknesses to the mean of the wall radii.

18. (Previously Presented) The method of Claim 8, wherein the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors for the lumen comprises the step of calculating:

(a) a plurality of area descriptors;

(b) a plurality of simple descriptors, each simple descriptor being based on a one dimensional distance determined for the lumen; and

(c) a plurality of complexity descriptors, each complexity descriptor being based on two different dimensional distances determined for the lumen.

19. (Original) The method of Claim 18, wherein each morphological descriptor is automatically calculated by a computing device.

20. (Original) The method of Claim 18, wherein the lumen is a blood vessel of a patient, further comprising the step of analyzing the plurality of morphological descriptors to evaluate whether the patient is at risk for having a stroke.

21. (Original) A memory medium on which machine executable instructions are stored for carrying out the steps of Claim 1.

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22. (Previously Presented) A method for estimating a thickness of a wall of a lumen, comprising the steps of:

(a) identifying an inner contour and an outer contour of the lumen;

(b) generating a plurality of edges between the inner contour and the outer contour using multiresolution tiling;

(c) analyzing the plurality of edges using a Delaunay triangulation minimal energy function to identify edges that correspond to a width between the inner contour and the outer contour;

(d) comparing edges identified as corresponding to a width between the inner contour and the outer contour to identify a minimum width and a maximum width; and

(e) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

23. (Original) The method of Claim 22, further comprising the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors for the lumen.

24. (Previously Presented) The method of Claim 23, wherein the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors comprises the step of calculating:

(a) a plurality of area descriptors;

(b) a plurality of simple descriptors, each simple descriptor being based on a one dimensional distance determined for the lumen; and

(c) a plurality of complexity descriptors, each complexity descriptor being based on two different dimensional distances determined for the lumen.

25. (Original) A memory medium on which machine executable instructions are stored for carrying out the steps of Claim 22.

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26. (Previously Presented) A method for estimating a thickness of a wall of a lumen, comprising the steps of:

(a) identifying an inner contour and an outer contour of a lumen;

(b) decomposing each of the inner contour and outer contour into a low resolution set of discrete points for the inner contour and a low resolution set of discrete points for the outer contour;

(c) employing a triangulation function to define triangles between the discrete points in each low resolution set;

(d) adding additional triangles between the inner contour and the outer contour;

(e) analyzing edges of the triangles that were defined and added to identify triangle edges that correspond to a width between the inner contour and the outer contour;

(f) comparing the triangle edges to identify a minimum width and a maximum width; and

(g) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

27. (Original) The method of Claim 26, wherein the step of adding additional triangles between the inner contour and the outer contour comprises the steps of:

(a) inserting additional points onto each of the inner contour and the outer contour, such that triangles defined between the inner contour and the outer contour are converted to quadrilaterals; and

(b) constructing an edge from each point that was inserted to a corresponding quadrilateral vertex on the other contour, thereby converting each quadrilateral into a pair of triangles.

28. (Original) The method of Claim 26, wherein the step of analyzing triangle edges comprises the step of using a Delaunay triangulation MaxMin angle property to determine a minimal energy function.

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29. (Original) The method of Claim 26, further comprising the steps of repeating steps (e) and (f) until a desired resolution is achieved, such that additional triangle edges identified as corresponding to the width between the inner contour and the outer contour are compared to identify the minimum width and the maximum width.

30. (Original) The method of Claim 26, further comprising the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors for the lumen.

31. (Original) A memory medium on which machine executable instructions are stored for carrying out the steps of Claim 26.

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32. (Previously Presented) A method for estimating a thickness of a wall of a lumen, comprising the steps of:

(a) identifying an inner contour and an outer contour of the lumen;

(b) decomposing the inner contour and the outer contour into a set of low resolution contours, to produce a pair of low resolution contour sets;

(c) computing tiling to generate triangles for each low resolution contour set in which each triangle includes at least one cross edge extending between the inner contour and the outer contour;

(d) labeling each cross edge as a suspect edge;

(e) edge flipping each triangle relative to a cross edge thereof using a minimal energy function to identify cross edges that correspond to the width between the inner contour and the outer contour;

(f) inserting a new vertex into each low resolution contour set, such that triangles defined by the pair of low resolution contour sets are converted to quadrilaterals;

(g) constructing an edge from each inserted vertex in one of the low resolution sets of the pair to a corresponding quadrilateral vertex in the other low resolution contour set of the pair, to convert each quadrilateral into a pair of triangles;

(h) labeling each cross edge as a suspect edge;

(i) edge flipping each triangle relative to a cross edge thereof using the minimal energy function, to identify cross edges that correspond to the width between the inner contour and the outer contour;

(j) repeating steps (f)-(i) until a desired resolution is achieved;

(k) comparing cross edges identified as corresponding to the width between the inner contour and the outer contour to identify a minimum width and a maximum width; and

(l) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

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33. (Original) The method of Claim 32, further comprising the step of using the inner contour, the outer contour, the minimum width and the maximum width to calculate a plurality of morphological descriptors for the lumen.

34. (Original) A memory medium on which machine executable instructions are stored for carrying out the steps of Claim 32.

35. (Previously Presented) A system for analyzing a lumen to determine dimensions of the lumen, including wall thickness, comprising:

(a) imaging apparatus that produce an image of a lumen within a body of a patient; and

(b) a computing device coupled to the imaging apparatus to control it, said computing device including:

(i) a memory in which machine instructions are stored; and

(ii) a processor coupled to the memory, said processor executing the machine instructions to control the imaging apparatus to carry out a plurality of operations, including:

(1) identifying an inner contour and an outer contour of the lumen;

(2) generating a plurality of edges between the inner contour and the outer contour using multiresolution tiling;

(3) analyzing the plurality of edges using a Delaunay triangulation minimal energy function to identify edges that correspond to a width between the inner contour and the outer contour;

(4) comparing edges identified as corresponding to a width between the inner contour and the outer contour to identify a minimum width and a maximum width between the inner contour and the outer contour, corresponding respectively to a minimum wall thickness and a maximum wall thickness of the lumen; and

(5) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

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36. (Previously Presented) The system of Claim 35, further comprising a display coupled to the processor, wherein the machine instructions further cause the processor to display a discrete image of a selected slice of the lumen.

37. (Original) The system of Claim 35, wherein the machine instructions further cause the processor to calculate a plurality of morphological descriptors for the lumen, the morphological descriptors including:

(a) a plurality of area descriptors;

(b) a plurality of simple descriptors, each simple descriptor being based on a one dimensional distance determined for the lumen; and

(c) a plurality of complexity descriptors, each complexity descriptor being based on two different dimensional distances associated with the lumen.

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38. (Previously Presented) A system for analyzing a lumen to determine dimensions of the lumen, including wall thickness, comprising:

(a) a computer configured to process an image of a lumen, said computer including:

(i) a memory in which machine instructions are stored;

(ii) a display configured to display an image of a lumen; and

(iii) a processor coupled to the memory and the display, said processor executing the machine instructions to carry out a plurality of operations, including:

(1) in an image of the lumen, identifying an inner contour and an outer contour;

(2) performing a low resolution triangulation function to define triangles between the inner contour and the outer contour;

(3) adding additional triangles between the inner contour and the outer contour;

(4) analyzing edges of the triangles that were defined and added using a minimal energy function to identify triangle edges that correspond to a width between the inner contour and the outer contour;

(5) comparing triangle edges identified as corresponding to a width between the inner contour and the outer contour to identify a minimum width and a maximum width corresponding respectively to a minimum wall thickness and a maximum wall thickness of the lumen; and

(6) having identified the minimum width and the maximum width, executing at least one step selected from the group consisting of the following steps:

(i) storing indications of the minimum width and the maximum width such that the indications are available for later use by a user; and

(ii) outputting indications of the minimum width and the maximum width to a user.

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39. (Original) The system of Claim 38, wherein the machine instructions further cause the processor to iteratively add additional triangles between the inner contour and the outer contour until a predetermined resolution is achieved.

40. (Previously Presented) The system of Claim 38, wherein the machine instructions further cause the processor to perform the low resolution triangulation function by implementing the following operations:

(a) decomposing the inner contour into a low resolution inner contour set using wavelet analysis, and decomposing the outer contour into a low resolution outer contour set using wavelet analysis; and

(b) computing tiling for the low resolution inner contour set and the low resolution outer contour set using greedy triangulation.

41. (Original) The system of Claim 38, wherein the machine instructions further cause the processor to analyze the edges of the triangles using a Delaunay triangulation MaxMin angle property to determine the minimal energy function.

42. (Original) The system of Claim 38, wherein the machine instructions further cause the processor to analyze triangle edges by performing an edge flipping operation on the edges of the triangles.

43. (Original) The system of Claim 38, wherein the machine instructions further cause the processor to add additional triangles between the inner contour and the outer contour by implementing the following operations:

(a) inserting vertices onto each of the inner contour and the outer contour, such that triangles defined between the inner contour and the outer contour are converted to quadrilaterals; and

(b) constructing an edge from each inserted vertex on one of the inner contour and the outer contour to a corresponding quadrilateral vertex on the other of the inner contour and the outer contour, thereby converting each quadrilateral into a pair of triangles.

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44. (Original) The system of Claim 38, wherein the machine instructions further cause the processor to calculate a plurality of morphological descriptors for the lumen, the morphological descriptors including:

(a) a plurality of area descriptors;

(b) a plurality of simple descriptors, each simple descriptor being based on a one dimensional distance determined for the lumen; and

(c) a plurality of complexity descriptors, each complexity descriptor being based on two different dimensional distances determined for the lumen.

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